SATELLITES IN THE SERVICE OF GEOGRAPHY

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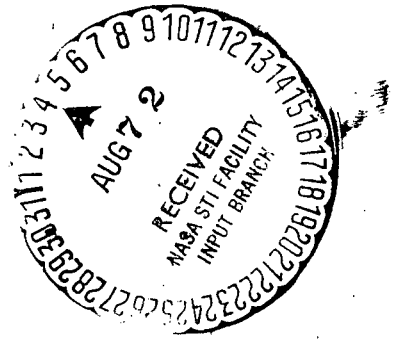
Translation of "Satelliten im Dienste der Geographie," Weltraumfahrt Raketentechnik, Vol. 22, Oct.-Nov. 1971, pp. 165,166, 168-170.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C. 20546 JUNE 1972

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ABSTRACT. Three examples of uses of satellites in geography are given. Land clearance by fire for farming in certain countries is described. Satellite shots permit supervision of this process and determination of wind directions from trails of smoke recorded on photos, which is especially useful in areas with limited meteorological services. Satellite photos are used to discuss the phenomenon of cloud coverage over most of Central Europe. Local weather variations can be observed by satellite, where land and sea wind circulations create conditions different from the general meteorological situation. The use of satellite pictures in automatic printing of maps is also discussed. Computer processing by digital or chemical processes is feasible. A digital system using the equidensity method is described. It comprises a mechanical scanner, processor (resolution 7 lines/mm) and image reproduction device. Threshold values of the density reference values are used for processing the images.

Examples 1 and 2: Land Clearance by Fire and Weather in Coastal Regions /165*

Trails of smoke on satellite pictures are frequently interpreted as forest fires. But in most cases, they are the result of land clearance by fire. By means of satellite photographs, it is possible - as is shown in the first example - to control these land clearances by fire and also to observe the main wind directions, which are indicated by these trails of smoke as if they were "weather vanes." In the second example, we are discussing the cloudless coastal border area of western France at a time when the rest of Central Europe is covered by a cloud cover.

1. Farming on the earth, especially in climates where periods of precipitation alternate with dry periods, frequently use the agricultural

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* Numbers in the margin indicate pagination in the original text.

form of land clearance by fire. In this manner, numerous new fields for the cultivation of agricultural food plants are created by burning down bush and forest areas at the end of the dry season. But, simultaneously, an irreversible soil erosion is fostered by this method due to the fact that the soil on slopes and inclined areas is laid bare. Large areas in many countries of the world have been robbed of fertile soil in this manner.

K. Helbig wrote the following on land clearance by fire in the southern-most state of Mexico, Chiapas: "Haze develops on account of the numerous fires in forests, bush, and grassland. Near the end of the dry season, there is no day without gigantic clouds of smoke drifting from the mountain slopes and the planes across the land." And a little later, he speaks of "a triumph of thoughtless destruction which, according to the unrelenting laws of nature, must necessarily lead to a constant deprivation of the soil and the entire country." Figure 1 shows an example of this method: Land clearance by fire in Chiapas, Mexico.

Of additional interest here are the directions of the trails of smoke. During the season in which the photograph in Figure 1 was taken - in March, the end of the dry season lasting from October until April - the sky above this landscape is often cloudless. Merely a front of cumulus clouds indicates by its position the 2,000-m high ridge of the Sierra Madre of Chiapas. Because there are only a few meteorological stations, and no meteorological balloons are used in this region, the trails of smoke can be used as indicators of the directions of ground wind and winds at low altitudes above this area. The line of sight in Figure 1 is directed toward the SW to the Pacific Ocean. While the trails of smoke in the coastal plane (Soconusco) indicate west wind, it can be seen from the trails of smoke in the interior, approximately 120 km from the Pacific coast, that the wind is NNW there.

This region is under the influence of numerous different wind systems: from the NE the trade winds, from the NW the norther (here it is responsible for the direction of the trails of smoke in the interior of the country), and wind from the Pacific Ocean. The determining factors for the meteorological conditions here, according to Helbig, are the pressure gradient between the Atlantic Ocean and the Pacific Ocean, with Chiapas lying

inside the zone of the northeasterly trade winds, and the influence of the orographic structure of the country on the climate. The atmospheric pressure over the northern Gulf and the Pacific coastal plane lies at 765 and 758 mm, respectively, during January, and at 760 and 757, respectively, during April. The borderline between Atlantic and Pacific movements of air shifts continuously as the atmospheric pressure changes.

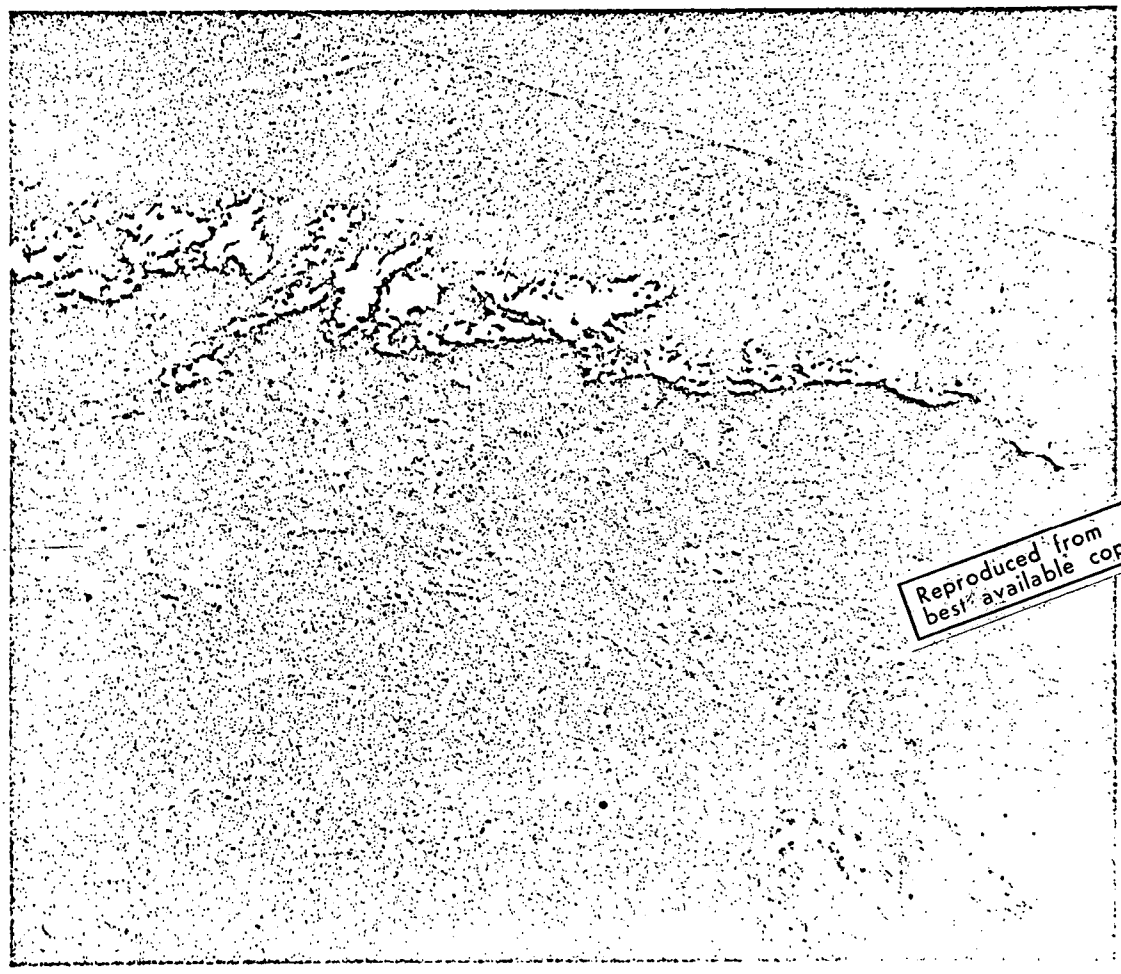

Figure 1. Apollo 9 photograph taken above southern Mexico. View towards the Pacific coast of Chiapas. Approximately 15 sites of land clearance by fire can be identified from their trails of smoke, which cover the area over sections of 30 to 50 km. Altitude of shot 180 km, position of sun 40° altitude.

The second example is illustrated in Figure 2. Our interest here is focused on the cloud coverage over the coastal area of western France.

While the cloud coverage is basically caused by the general meteorological situation, clouds may result locally from the distribution of land and water and the relief of the area. The area between Biarritz in the south and Les Sables d'Olonne in the north is cloudless in a strip of about 20 to 30 km inland from the coast and about 30 to 40 km out to sea: the condition of good weather in the resort areas on the ocean. At the same time, all of France is covered by clouds with the exception of the Bretagne and the coast near Toulon on the Mediterranean. /166

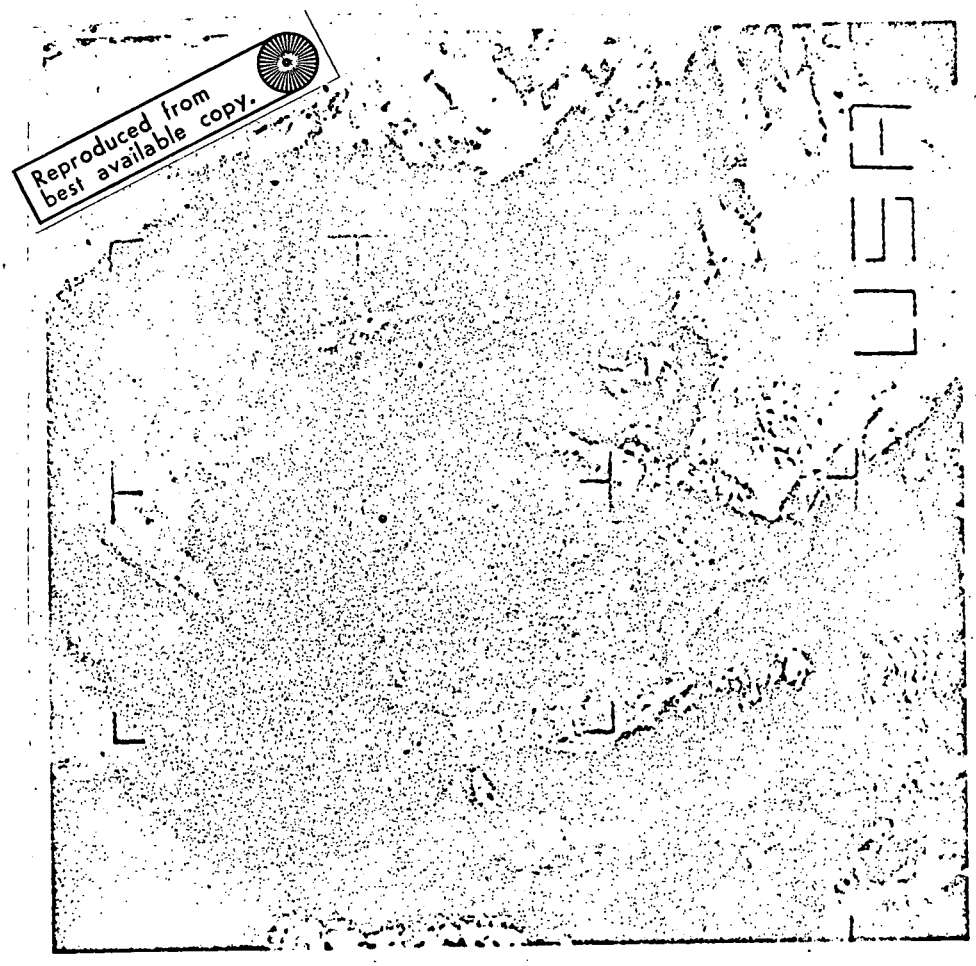

Figure 2. Photograph taken by the ITOS 1 weather satellite on 16 July 1970. While western Europe is under a cloud cover, a narrow strip on the French southern coast of the Atlantic is cloudless.

The shot was made available for geographic evaluation by H. Kaminski, Bochum.

This satellite shot is an excellent example of the good weather zone on the coast created locally by the circulation of land wind and sea wind. Its value for weather reports, here European resort areas, is obvious. In this case, the local circulation of land wind and ocean wind in the coastal area predominates over the cloud cover produced by the general meteorological situation.

Example 3: Automatic Production of Maps According to Satellite Photographs

It is the purpose of the studies described here to prepare satellite shots in such a way by means of a computer that maps can be printed out automatically. We are dealing here with an electronic equidensity method.

Figure 3 shows a view of an area of southern California which has become known from numerous publications: The depression of the Imperial Valley with the Salton Sea. The location of individual settlements and cities, such as El Centro, Mexicali, and others, within the cultivated region is clearly visible in the picture. The Imperial Valley is the natural northern end of the Gulf of California and is a trench-like depression linked to the San Andreas Fault [1]. The gulf was cut off by the Colorado, which carries along mud and suspended matter in amounts that are greater than average. The depression north of the cut-off line has dried out; and what has remained is a depression, the lowest point of which is approximately 100 m below sea level. This depression with its fertile bottom land soil has been made use of by the irrigation plan of the Imperial Valley. Today, the major portion of the water from the Colorado River flows to the various irrigation areas. In the Imperial Valley, excess water of the irrigation system flows into the Salton Sea, which fills the lowest point of the depression.

The large, rectangular fields can be clearly distinguished in the irrigated area. After surveying the area, the subdivisions were made strictly in a N-S and E-W direction. Approximately 60 units of 1 square kilometer each are arranged in one row alone. The individual fields differentiated in color in accordance with the plant grown there; especially clearly visible is the alfalfa grass which appears as a bluish green before it is cut.

Therefore, this picture demonstrates clearly the intervention of man in the previously dry and hot desert country without vegetation in the Southwest of the USA.

To simplify the evaluation of such pictures, various methods of image processing may be used. The processes concerned are equidensity methods which may be carried out by chemical processes (compare UMSCHAU 1971, No. 11, p. 398; No. 20, p. 739) by electronic methods. This study will discuss the electronic treatment with a scanner and computer. The objectives are automatic processing of the image and automatic map printing.

Figure 3 was processed by scanning by means of a computer in such a way that two outputs appear (Figures 4 and 5); a pseudo-plastic representation of the picture and a black and white picture of specific equidensity. /168

The picture processing equipment consists of a mechanical scanner, a computer and an image reproduction device. Resolution of the scanner is 7 lines/mm. Total time for processing of a picture of approximately 20 x 20 cm is 13 minutes. The method of equidensities of the first order is realized in digital image processing by setting an interval in the program by means of two threshold values in the density reference scale of the unprocessed image. All image points whose density reference value fall within the fixed interval, are drawn in black, all other image points appear as white. The position and length within the gray scale may be selected at random and may be fed into the computer via a teletypewriter prior to processing.

The pseudoplastic image representation is achieved in the following manner: Prior to the beginning of the processing of the image, the entire density reference range of the image is divided into quantizing stages by means of threshold values, which are fed to the program, and adjacent gray values from the center of the scale of density reference values are assigned to these quantizing stages. Without discussing the mathematical details involved here, it should be mentioned, however, that the scanned image function is differentiated and quantized during image processing. Subsequently, the first derivative of the image function is superimposed on the gray value in an additive manner. The processed image (Figure 4) appears to the viewer

as a scenery which is illuminated from the direction of differentiation and creates the impression of a relief in gray tones. We are dealing here with a well-known psychological and optical phenomenon which may be reversed by intensive lighting from the opposite direction. Though this image output permits a differentiated and qualitative interpretation of land usage, it cannot be printed without any further operations since it is a semi-tone image.

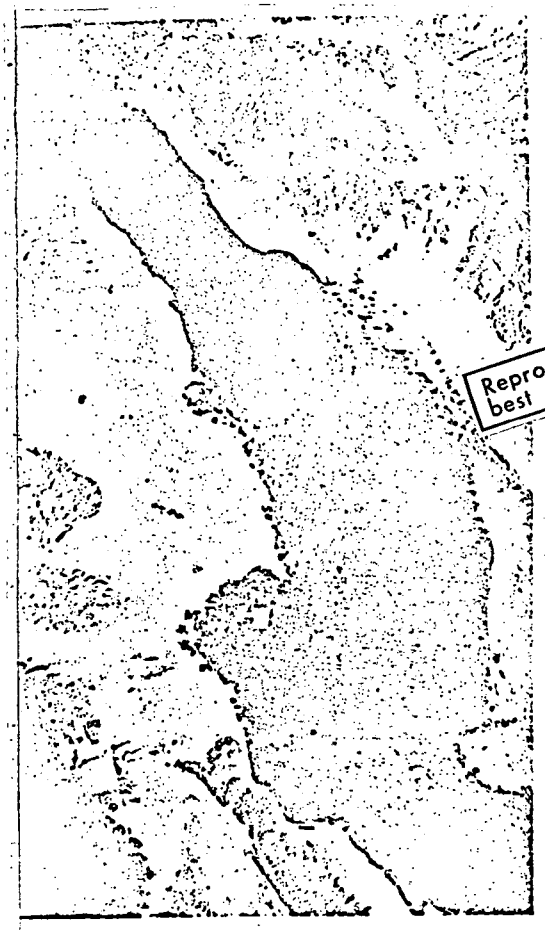

Figure 3. Surrounded by mountain chains of the Mojave Desert lies the purely geometrically designed carpet of cultivated areas of the artificially irrigated Imperial Valley in Southern California. Communities and cities can be recognized as lighter areas between the rectangular, large fields (picture taken by Apollo 9).

The black-and-white representation of a specific equidensity, which shows some plant cultivations in its band width as output, is illustrated

in Figure 5. This representation can be electrotyped as a black-and-white line drawing and can be printed directly in an offset printing process.

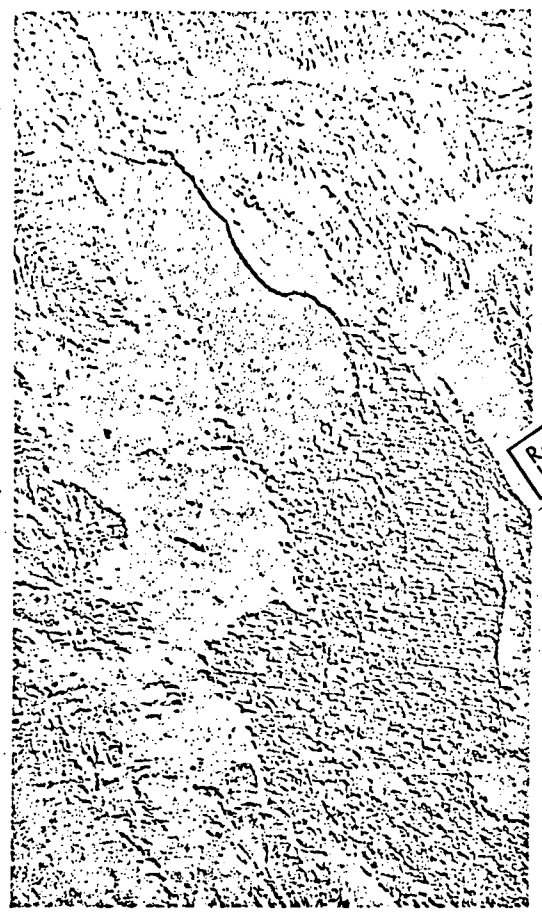

Figure 4. Result of digital image processing of Figure 3: Pseudo-plastic representation. Settlements here appear "raised" with respect to the cultivated fields.

The digital processing method requires a large amount of instruments but it permits more readily measureable and better focused excerpts. If a great number of photographs is to be evaluated, this method is the only economical method of processing and evaluation. If meaningful processing is to be achieved, it is, of course, essential that the person requesting the information, e.g., the geographer, cooperates with the technologist, the electronics specialist and information specialist, and also the scientific photographer, as has been the case in the example described here.

Figure 5. Black-and-white representation of a specific equidensity, the bandwidth of which was selected in such a way that certain plant cultures can be distinguished. This representation is excellently suited for use as automatically produced map for offset-printing.

REFERENCES

1. Bodechtel, J., Gierloff-Emden, H. G., Weltraumbilder der Erde [Space Shots of the Earth], Paul List Verlag, Munich, 1969.

2. Gierloff-Emden, H. G., Mexico - Eine Landeskunde [Mexico - A Geography], Walter de Gruyter, Berlin, 1970.

3. Helbig, K., "The River Area of the Upper Rio Grijalva; A Study of the District of Chiapas, Southern Mexico," Mitteilungen der Geogr. Ges., Hamburg, 54, 1961, pp. 7-295.

4. Helbig, K., "The District of Soconusco in the State of Chiapas, Southern Mexico and Its Coffee Region," Deutsche Geographische Blatter (Geogr. Ges., Bremen) 49, No. 1-2, 1961.

Translated for the National Aeronautics and Space Administration under contract No. NASw-2038 by Translation Consultants, Ltd., 944 South Wakefield Street, Arlington, Virginia 22204.